C. Remarks

The claims are 1, 7, and 9, with claims 1 and 9 being independent. The independent claims have been amended to better define the invention. Support for this amendment may be found, for example, in the specification at page 8, lines 20-25. No new matter has been added. Reconsideration of the present claims is expressly requested.

Claims 1, 7, and 9 stand rejected under 35 U.S.C. § 103(a) as being allegedly obvious in view of the allegedly admitted prior art on page 6, line 22, through page 8, line 25, as exemplified by JP 6-27302 (Baba) and JP 8-258051 (Kawasaki). The grounds of rejection are respectfully traversed.

In the Advisory Action dated January 16, 2009, the Examiner alleged that the determination of an acceptable diameter for the electroplating would have been within the skill level of the art and would call for no more than routine experimentation on the part of one of skill in the art, even if the prior art does not teach varying the diameter. In that connection, the Examiner noted that the applied prior art references are in Japanese and translations thereof would have to be obtained to determine if there is any disclosure of the diameter size.

Also, the Examiner alleged that the diameter necessarily depends on the desired size of microlens and, as such, does not have to be disclosed as a result-effective variable to allow the application of an optimization principle. According to the Examiner, Applicants merely found a certain range over which the mold is most expeditiously made. That does not mean that the mold cannot be made should the diameter of the opening not be within the recited range (e.g., the value for the diameter can be as small as desired).

The Examiner recognized that when the diameter exceeds a certain value with respect to the radius of the curvature of the resultant lens, the mold cannot be formed. However, the Examiner took the position that this value would have been readily determined through routine experimentation, and that the very act of electroplating would allow the desired radius to pass through a minimum before the desired value is reached. Applicants respectfully disagree for the reasons discussed in detail below.

As recited in the present claims, a mold for a microlens is formed by electroplating using the conductive portion of the substrate as a cathode to deposit a plated layer in the opening and on the mask layer. Importantly, electroplating is terminated when the plated layer reaches the desired radius (R) of curvature only after forming a minimum radius (R_{min}) of curvature. This is not disclosed or suggested in the cited art, nor is plating through R_{min} inherent. Applicants respectfully submit that electroplating need not pass through R_{min} in order to achieve the desired radius.

As illustrated in Figs. 3B and 3C in the subject application, when electroplating is initiated in accordance with the present invention, the plated layer 5 has a flat portion right above the opening 4:

FIG.3B

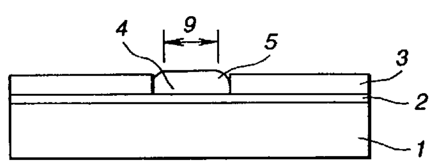
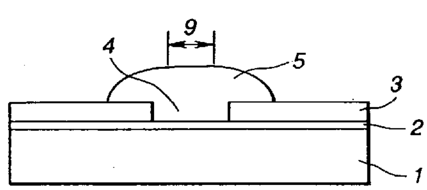


FIG.3C



Accordingly, there is no curvature radius present at this time (indicated by a "flat portion" in Fig. 5).

As the electroplating growth proceeds, the flat portion disappears and the plated layer 5, in turn develops, a curvature radius. Importantly, after this curvature radius is formed (Fig. 3D), continued electroplating reduces this radius until it reaches R_{min} (e.g., Fig. 3E):

FIG.3D

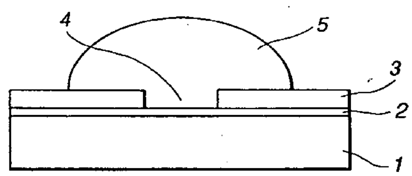
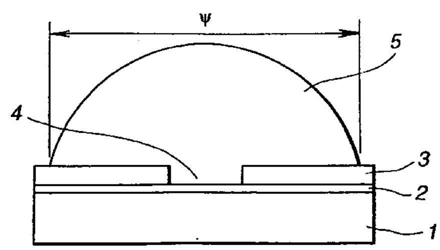
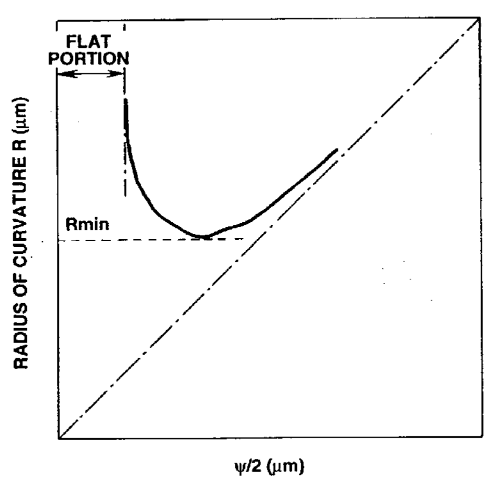


FIG.3E

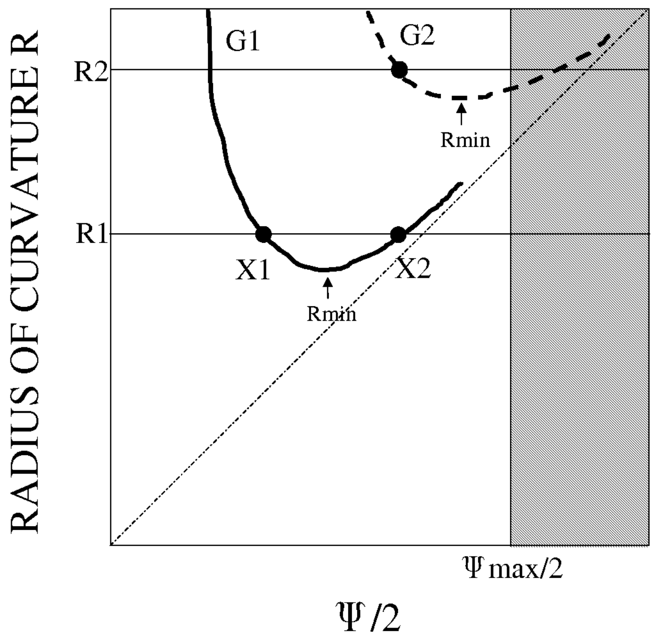


Then, if the electroplating is again continued, the size of the plated layer 5 increases along with the curvature radius. Accordingly, the curvature radius of the plated layer 5 gradually increases from R_{min} along with the layer, as illustrated in Fig. 5:

FIG.5



The graph below illustrates in more detail the relationship between the radius of the bottom of the plated layer ($\psi/2$) and the curvature radius similar to Fig. 5:



As shown in this graph, if the opening diameter is large, the plating proceeds as shown by line G2. In this instance, R_{min} is large and the produced lens is limited to the one with a large curvature radius. If a distance between adjacent lenses is determined, the upper limit of $\Psi/2$ is indicated as $\Psi max/2$ in the graph. In this case, it is not possible to achieve radius R2 by electroplating through R_{min}, so that only a dark lens is produced by this electroplated mold. Thus, while it may be possible to achieve a desired curvature radius by electroplating over an opening of a certain size, it does not mean that this desired radius is achievable by electroplating over such an opening by passing through R_{min}. In this case, a mold with superior properties cannot be formed by plating through R_{min} unless $\varphi \leq 0.35R$.

If the opening diameter is smaller, electroplating proceed as shown by line G1. This line demonstrates that the variations in the radius of the plated layer can result in it reaching desired radius R1 two times during the plating process. However, at point X1,

the plated layer has a small bottom diameter so that only a dark lens is obtained if such a mold is used. At point X2, once electroplating proceeded through R_{min}, the bottom diameter and R1 are almost the same, so that the shape of the plated layer is almost hemispherical. Thus, a bright and clear lens can be produced.

Thus, if the desired curvature radius is R1, electroplating can be stopped at point X1 without proceeding to point X2 through R_{min}. However, Applicants discovered that the properties of the electroplated mold (and consequently the formed lens) are superior when R1 is achieved by plating through R_{min} to point X2. Applicants respectfully submit that this is neither disclosed nor suggested by the cited art, nor would it be inherent in the electroplating procedure, since electroplating can be stopped at point X1 without passing through R_{min}.

In any event, since neither Baba nor Kawasaki discloses or suggests plating through R_{min}, and plating through R_{min} is not inherent, it is clear that one skilled in the art would not look to optimize the opening so that plating through R_{min} could be conducted based on the teachings in these references.

Furthermore, as is now specified in the claims, the curvature radius in an upper part of the plated structure is 200 μm or less. Baba, the full English language of which was submitted in parent Application No. 09/360,455,[1] discloses that the base area of a convex structure 3 (a portion that becomes an anchor formed in a conductive layer 2 in Fig. 1(B), which is different from the bottom diameter of the convex structure 3 in the front side) is one to two times larger than the area of an opening of a rear portion 4 to prevent the convex structure from dropping out of the opening. However, Baba fails to disclose that

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[1] The translations of both Baba and Kawasaki were submitted during prosecution of the parent application. For the Examiner's convenience, copies of these translations are provided herewith.

the curvature radius is 200 μm or less or the relationship between the opening diameter and the curvature radius.[2]

As explained in detail during prosecution of the parent application, this is an important consideration. The claimed relationship between the radius of the curvature and the opening diameter is not obvious. For example, if the radius of the curvature is less than or equal to 200 microns, the diameter of the opening is not inherently less than or equal to 70 microns. Achieving a curvature radius of 200 microns requires more than simply setting the diameter of the opening to 70 microns. The curvature radius or shape will also depend, for example, on numerous electroplating conditions.

Kawasaki also fails to disclose curvature radius of curvature of 200 μm or less. Applicants submit that if the opening diameter is further reduced in Fig. 7 of Kawasaki, the curvature radius would appear to be saturated.

In sum, Applicants respectfully submit that the prior art fails to disclose or suggest electroplating through the formation of R_{min} and the presently claimed opening range. Thus, the presently claimed invention is clearly patentable over prior art.

For at least the reasons discussed above and in the December 29, 2008 Response, Applicants respectfully request that the rejection under 35 U.S.C. § 103(a) be withdrawn.

Wherefore, allowance of the claims and expedient passage to issue are respectfully requested.

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2 Baba discusses a relationship between the undersurface area of the convexity and the aperture area in the Abstract and paragraph [0012]. Since the undersurface area is determined by a pitch of the lens array and the radius is determined by optical characteristics of the lens, there is no direct relationship between the undersurface area of the convexity and the radius of the curvature.

Applicants' undersigned attorney may be reached in our New York office by telephone at (212) 218-2100. All correspondence should continue to be directed to our address given below.

Respectfully submitted,

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